Sun™ Enterprise Network Array™ A5000

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Sun™ Enterprise Network Array™ A5000 Positioning
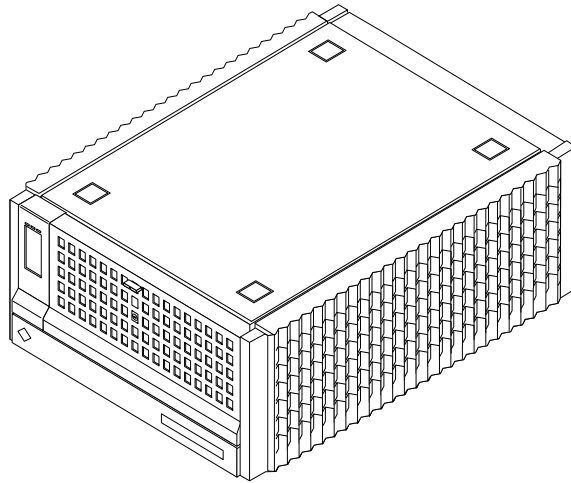
Introduction

The Sun™ Enterprise Network Array™ A5000:

- Replaces the SPARCstorage™ Array family.
- Far exceeds the SPARCstorage Array in reliability, availability, serviceability (RAS), performance, and scalability.
- Inaugurates Sun's Open Storage Networks, a new model for high-performance enterprise storage that Sun plans to develop over the next several years.

As the replacement for the highly successful SPARCstorage Array, the Sun Enterprise Network Array fits an extensive range of applications, ranging from 45-GB E3000 configurations to over 20-TB (terabyte) cluster configurations.

The Sun Enterprise Network Array dramatically improves on RAS (redundant and hot-swappable power, drives, cooling, and interfaces), performance (dual 100-MB/sec. fibre paths to each disk), scalability (4x bandwidth, 3x drives, 2x hosts), and manageability (local touchscreen, remote system monitoring and `luxadm` configuration and monitoring), while retaining the SPARCstorage Array 1xx's flexible form factor. These features mean the Sun Enterprise Network Array meets the most demanding enterprise availability and performance requirements.

Because of its scalability, the Sun Enterprise Network Array is easily configured to meet the most demanding commercial OLTP, database, financial, and manufacturing applications. The 100-MB/sec. full-duplex Fibre Channels enable the array to excel at bandwidth-intensive applications such as data warehousing, web servers, seismic analysis, video production, MCAD and other technical applications.

Product Family Placement

The Sun Enterprise Network Array replaces the SPARCstorage Array family for all but the most price sensitive customers. Even with the many built-in RAS features, and the slightly higher cost of Fibre Channel disk drives, Sun Enterprise Network Array configurations cost less than 10% more per megabyte than the SPARCstorage Array. This cost is minimal for most customers when compared with the availability and performance benefits.

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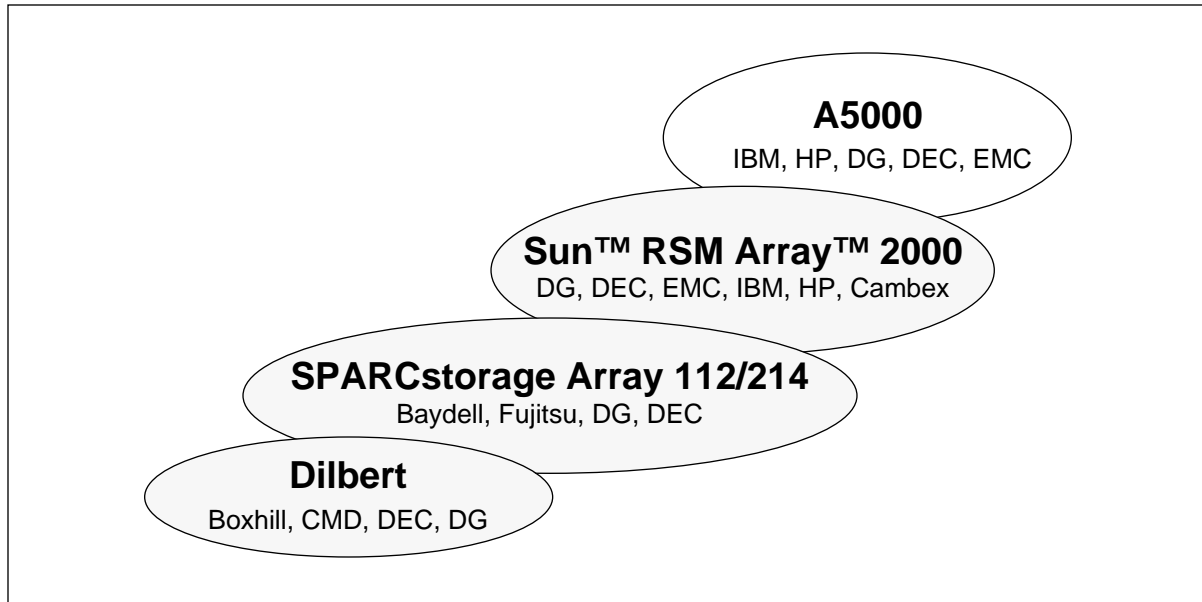
Figure 1. RAID system capacity.

Product Family Placement *(cont.)*

The Sun™ RSM Array™ 2000 is the product of choice for those customers whose applications have one or more of the following requirements:

- Stable capacity requirements (scalability is not needed)

- Centrally managed remote sites with limited onsite systems administration support (RSM2000 is easier to manage remotely)

- Customer needs controller-based RAID (Sun Enterprise Network Array uses host-based RAID)

Key Messages

The Sun Enterprise Network Array offers high performance, high RAS, and leading-edge technology:

1. High Performance

Performance testing continues, but early results are unequivocal: the Sun Enterprise Network Array provides exceptional raw system performance. How exceptional? Over 7,000 IOPS (input/output per second) per loop (these are dual-loop systems) and 95 MB/sec. of actual user-data bandwidth per loop. Our only announced competitor, DG, is claiming performance of 5,000 IOPS and 75 MB/sec. per loop. (Performance testing is summarized in the "Test Results" table under "Performance Summary" in the "System Architecture" section. The complete report is available on the World Wide Web—see the "Complete Performance Report" web site in the Materials Abstract.)

2. High RAS (Reliability, Availability, Serviceability)

The RAS features of this array exceed the features of the SPARCstorage Array family. For example, the Sun Enterprise Network Array features dual paths to each disk; no SCSI array has this feature.

Feature	SPARCstorage Array	Sun Enterprise Network Array
Redundant power	No	Yes
Redundant interfaces (array)	No	Yes
Redundant interfaces (drive)	No	Yes
Hot-swappable drives	No	Yes
Hot-swappable power	No	Yes
Hot-swappable cooling	No	Yes
Hot-swappable interfaces	No	Yes
Diagnostics (FRU revision levels)	No	Yes
Diagnostics (host adapter)	No	Yes
Diagnostics (array interface)	No	Yes
Diagnostics (tray)	No	Yes
Automatic loop failover	No	Yes
Load balancing across loops	No	Yes
Full CRC datapath support	No	Yes

3) Sun's Strategic Storage Direction

Sun is the acknowledged industry leader in Fibre Channel, with more than 2,000 petabytes of Fibre-Channel-based storage shipped since 1993. The Sun Enterprise Network Array builds upon that leadership by extending the incorporation of next-generation Fibre Channel Arbitrated Loop (FCAL) all the way to the drives.

Availability

The Sun Enterprise Network Array is currently available for internal Sun orders for customer benchmarks, certification and demonstration use. A Limited Customer Ship (LCS) program is in place for early customer orders. These units will begin shipment in September. The formal public product announcement will take place in October, at which time the tabletop configuration is scheduled to begin shipping. Rack-mounted systems will be available in November. By the end of Q2/FY98 availability of all systems is expected.

Target Users

The Sun Enterprise Network Array is the central building block of the Open Storage Network, giving users a vision which begins with the second-generation Fibre Channel technology today.

Target User	Buying Influence Needs
MIS manager	FC-AL technology investment in the future
Procurement	Investment protection in FC-AL product line
Developer	Standards compliance for implementation of FC-AL products
Systems administrator	Flexible management in both software and hot-plug components
Operations	High availability, ensuring efficient system operation
End user	High performance, resulting in quick transaction response

Target Markets

Sun Enterprise Network Array is well-suited for the capacity and performance requirements required by modern databases, operations application servers, network data services and performance-oriented systems.

Industry/Customer	Key Features to Highlight
Disaster recovery	FC-AL future upgrade to a 10-km distance between arrays
Departmental storage	Tabletop design with proper capacity to support department sizes
Datacenter storage	Enterprise-class redundancy and mission-critical failover of components
Technical computing	High-performance data storage for engineering design projects
Scientific computing	High bandwidth for data capture, retrieval and storage
High-performance computing	FC-AL 100-MB/sec. interface for the most demanding performance needs
SPARCstorage Array upgrades	Priced and packaged to migrate customers

Applications

The Sun Enterprise Network Array suits storage applications where superior throughput and high availability are required.

Application	Requirements
Data warehousing	High, scalable capacity for building large databases
Decision support systems	High, scalable throughput for delivery of large records and reports
On-line transaction processing	Fast I/O in support of multiple transactions
Network file service	Fastest random-read performance for file delivery service
Enterprise clusters	Business-critical application availability

Selling Highlights

Market Value Proposition

Due to its scalability the Sun™ Enterprise Network Array™ is easily configured to meet the most demanding commercial OLTP, database, financial, and manufacturing applications. The 100-MB/sec., full-duplex Fibre Channels enable the array to excel at bandwidth-intensive applications such as data warehousing, web serving, seismic analysis, video production, MCAD and other technical applications.

Compatibility

The following systems support the Sun Enterprise Network Array. Maximums are still in test.

Sun™ System Supported	Maximum SBus FC-AL Host Adapters	Maximum Sun Enterprise Network Arrays	Maximum Supported Storage Capacity
Ultra™ Enterprise™ 10000	20	20	10 TB
Ultra Enterprise 6000	16	80	10 TB
Ultra Enterprise 5000	12	48	6 TB
Ultra Enterprise 4000	12	48	6 TB
Ultra Enterprise 3000	6	24	3 TB
SPARCcenter™ 2000(E)	20	80	10 TB
SPARCserver™ 1000(E)	4	2	1 TB

All maximum capacities noted are configured with single 127-GB enclosures. The maximum capacities on the on the Ultra Enterprise 10000 require full cabinet enclosure of 509 GB per cabinet. Twenty-TB testing on the Ultra Enterprise 10000 will be completed in November, 1997.

Technology Overview

Fibre Channel technology is the answer to the growing problems of SCSI-based peripherals. Fibre Channel is a high-performance serial interconnect standard designed for bidirectional, point-to-point communications between servers, storage systems, workstations, switches, and hubs. It offers a variety of benefits over other link-level protocols, including efficiency, high performance, scalability, simplicity, ease of use and installation, and support for popular high-level protocols.

An important enhancement to Fibre Channel has been the development of Fibre Channel Arbitrated Loop (FC-AL), developed specifically to meet the needs of storage interconnects. Employing a simple loop topology, FC-AL can support both simple configurations and sophisticated arrangements of hubs, switches, servers, and storage systems (see Figure 1, below). Furthermore, by using SCSI protocols over the much faster, more robust Fibre Channel link, FC-AL provides higher levels of performance without requiring expensive and complex changes to existing device drivers and firmware.
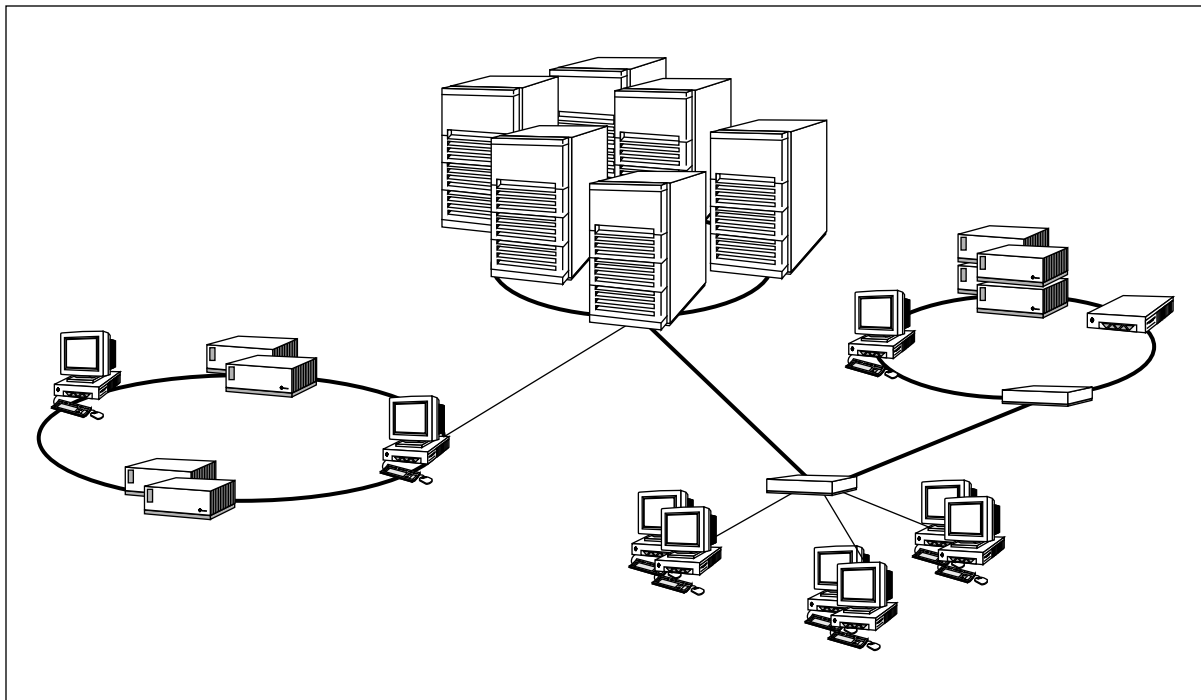
Figure 1. FC-AL's loop topology can support both simple and complex configurations.

Impressive Specifications

FC-AL-based storage systems will enable the creation of new applications that take full advantage of some impressive specifications:

Gigabit bandwidth

FC-AL is capable of data transfer rates of up to 200 MB/second (full duplex), with 400 MB/second envisioned for the future—far faster than SCSI, Serial Storage Architecture, or P1394 (Firewire®).

Suitability for networks

In addition to performance, Fibre Channel is ideal for building storage networks. Employing hubs and switches just like those used in networks, Fibre Channel will allow complex arrangements of storage and systems to be connected together in highly scalable, highly available networks, or fabrics.

Use of existing SCSI protocols

FC-AL allows SCSI command packets to be sent over a high-speed physical medium, reducing software and firmware costs and minimizing impact on existing software.

Node-addressability far better than SCSI

With the ability to support up to 127 FC-AL devices on a single host adaptor, cost and implementation complexity is greatly reduced. Using optical fiber media, a single FC-AL loop can support nodes with a separation of up to ten kilometers.

Greatly simplified wiring and cabling requirements

Because Fibre Channel is a simple, largely optical, serial protocol, electrical interference and expensive cabling are much less of an issue than with the complex parallel data paths used by SCSI.

In addition to these features, FC-AL supports redundant data paths, hot-pluggable components, multiple host connections, and dual ported drives—features that 15-year-old SCSI technology was never intended to support (see Table 1, below). The technical advantages of FC-AL alone would be enough to convince most that it clearly represents the future of high-speed peripheral interconnects, but FC-AL can also provide peace of mind to those who worry about the bottom line:

Industry-standard

The FC-AL development effort is part of the ANSI/ISO accredited SCSI-3 standard, helping to avoid the creation of nonconforming, incompatible implementations.

Broadly supported

All major system vendors (Sun, HP, DEC, Compaq, and others) are implementing FC-AL, as are all major disk drive and storage subsystem vendors. The Fibre Channel Association, an industry group dedicated to the promotion of Fibre Channel, is a *Who's Who* of systems, subsystems, drive, and component vendors. Such wide support ensures competition, lower costs, and user choice.

Enabling Technology

Impressive Specifications *(cont.)*

Vastly more flexible

Fibre Channel can also be used to do more than disk I/O—the Fibre Channel specification supports high-speed system and network interconnects using a wide variety of popular protocols, including HIPPI, TCP/IP, IPPI, FDDI, and ATM, in addition to SCSI. Many of the interconnect requirements of large enterprises may one day be met by Fibre Channel, promising lower costs, easier administration, and the easy deployment and redeployment of computing resources.

FC-AL Feature	SCSI Feature	Benefits
100 MB/sec. data rates	40 MB/sec. data rates	Throughput to match modern computing, peripheral and networking performance
127 devices per loop	16 devices per bus	Simpler, less expensive equipment requirements
Networking capability	None	Easier, simpler configuration of high-performance computing, file, and storage servers and clusters
Up to 10 km between nodes using optical fiber; up to 30 meter using cable	Up to 25 m differential	More flexible and secure hardware configurations
Hot-pluggability, dual porting	Hot plug, single porting	Support for high availability and disaster-tolerant configurations, disk arrays
Use of cyclic redundancy checks to ensure data integrity	Same	Better security and reliability
Simple serial protocol over a copper or fibre medium	Parallel over copper	Less expensive, less complex cable requirements
Use of standard protocols like IP and SCSI	Same SCSI protocols	Reduced impact on system software and firmware; leverages existing code

Table 1. Fibre Channel Arbitrated Loop (FC-AL) provides a number of important technical advantages.

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System Architecture

Overview of System Architecture

The Sun™ Enterprise Network Array™ A5000 is a high-availability mass storage subsystem that uses a disk enclosure capable of supporting up to 127 gigabytes of storage with greater capacities to come as disk capacities grow. Active components in the disk enclosure are redundant and may be replaced while the subsystem is operating. The system includes a SCSI Fibre Channel Protocol host adapter with dual Fibre Channel 100-MB FC-AL ports and supporting software. The A5000 disk enclosure is capable of supporting up to 22 one-inch disk drives or 14 1.6-inch disk drives. The enclosure is designed to be mounted in a standard Sun™ rack or on a table top. Up to four disk enclosures may be attached in a loop. One or two interface boards (IBs) may be installed in the enclosure. These boards provide FC-AL connections to the enclosure and additionally provide special services to report and control the state of the enclosure and its components. The enclosure has a front panel display and control panel that allow the configuration of the enclosure to be displayed and modified. No cables are used inside the A5000 disk enclosure.
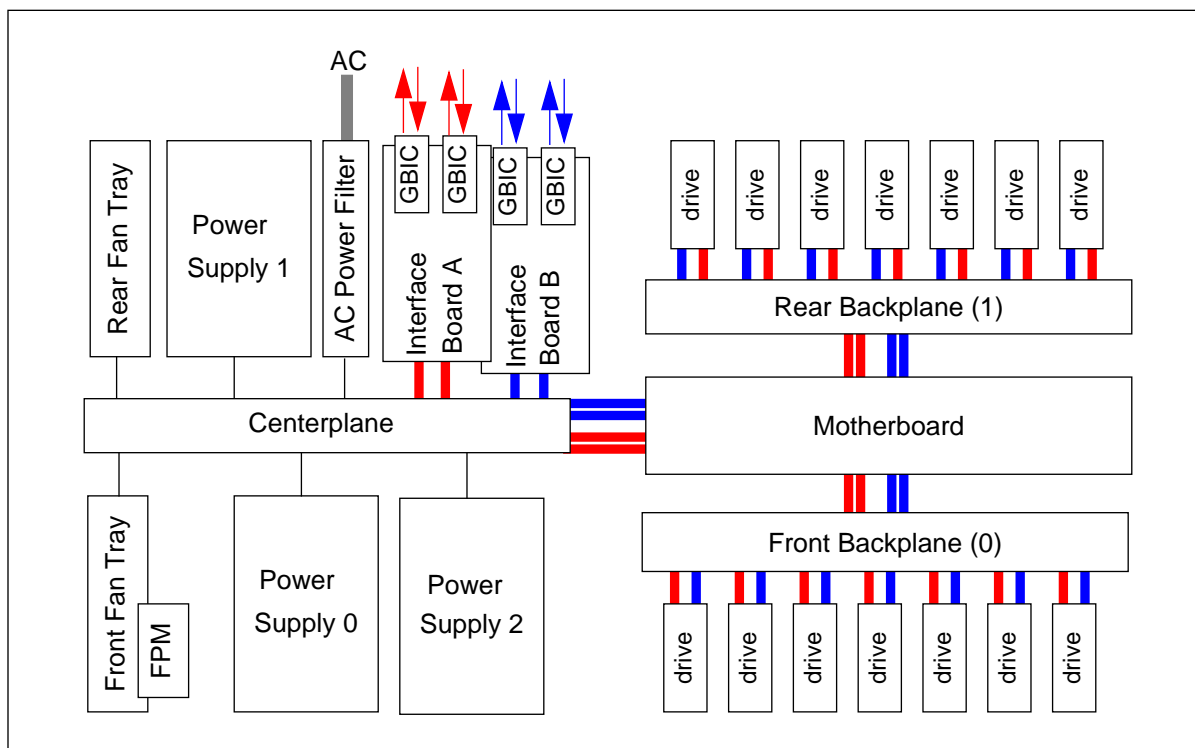

Figure 1. System architecture.

Interface Board

There are slots for two identical interface boards (IBs) in the lower rear of the A5000 enclosure. The IB provides all intelligent controls in the enclosure, sensing and setting the environmental service signals as required by conditions inside the enclosure. The IB interprets enclosure service commands from the host software or Front Panel Module (FPM) and performs the indicated enclosure management and sensing functions. The IB provides bypass services for two independent Fibre Channel FC-AL ports and manages the configuration of the internal loops. IB unit A serves port A on each FC-AL disk drive. IB unit B serves port B on each FC-AL disk drive.

Interface Board *(cont.)*

The A5000 enclosure can be configured as a single loop, a dual loop or as a split loop. When operating as a single loop, port 0 or 1 of the IB is connected to the Fibre Channel link. The other port is available for attachment of another A5000 enclosure or a host. When operating as a split loop, the front disk drives are connected to port 0 of the IB and the rear disk drives are connected to port 1 of the IB. This creates two separate FC-AL loops.

Loop Configurations

The A5000 uses a number of bypass circuits and multiplexors to allow reconfiguration of the nodes within the enclosure. The nodes can be configured as a full loop, or the loop may be split into two loops. Failing devices and circuits may also be bypassed. The loop configuration is controlled through the enclosure service commands set either from the host, by operator instructions through the FPM, or automatically (to bypass failing or missing elements under control of the IB).

Fibre Channel Disk Drives

All drives use the small-form-factor, 40-pin single-connector attachment (SCA) for FC-AL disk drives. Disks are half-height (HH–1.6 inch thick) type disk units. FC-AL disk drives are hot-pluggable; however, software preparations must be made for removal, replacement and additions to be properly recognized and configured. The FC-AL disks are dual-ported for multi-path access. The A and B disk ports are accessed through separate and independent interface boards which may additionally be multi-pathed.

An FC-AL disk drive is directly connected to the Fibre Channel Loop and appears as a node on the loop. It is identified by its unique World Wide Number (WWN). The FC-AL disk drives accept all standard SCSI commands, which are delivered directly via the Fiber Channel Loop—no SCSI interface is involved. This achieves higher throughput and less latency.

Gigabit Interface Converter (GBIC) module

The Gigabit Interface Converter (GBIC) module is a small hot-pluggable optical/electrical conversion unit that converts any of the standard Fibre Channel connector and signaling technologies to a *de facto* standard internal serial connection. The full speed of the module is 1,062.5 Mbit/sec.

The standard GBIC provided with the A5000 operates generically with either copper or optical connections. On one end is an electrical connection which interfaces with internal buses, while on the other end is an optical connection with the standard SC fiber cable connector. The GBIC uses a shortwave laser that operates at an inherently safe power level so that no Open Fiber Control safety circuits are required.

Using 50-micron fiber, the maximum length of a fiber should not exceed 500 meters. Controls to the GBIC allow for turning the transmitter on and off. Sense information from the GBIC indicates transmitter faults and loss of signal.

System Architecture

Host Adapter

The SOC+ Host Adapter (SOC+HA) is a single-width Fibre Channel SBus card. It operates in either 32- or 64-bit mode, and it has a second-generation Sun Serial Optical Channel ASIC (SOC+) processor. The host adapter implements two independent FC-AL interfaces operating at 100 MB/sec. One or two loops can be connected to each card using Gigabit Interface Converters (GBICs). The GBICs are hot-pluggable; the SOC+HA cards are not.

The SOC+HA supports both FC-AL loop and point-to-point FC-PH (SPARCstorage™ Array type) connections. However, the SPARCstorage Array is *not* supported on the SOC+ Host Adapter due to speed incompatibility. SOC+HA also provides an open interface for connection of other devices meeting the same Fibre Channel Protocol standards.

The Host Command Buffer (HCB) and the SOC+ programming interface process requests with only a single interrupt (or less). As "tag queuing" is supported and multiple response entries may be in the queue when the host services the interrupt, it is possible to achieve less than one interrupt per I/O request.

Enclosure Service

Two mechanisms are provided for an operator to interact with the A5000 disk enclosure. The FPM allows an operator to directly access most of the enclosure services. An operator can also access all the enclosure services through software (`luxadm`) running on the host computer. The SCSI Enclosure Services (SES) device model is used. This runs on the selected IB's SOC+ chip using the Fibre Channel Protocol for SCSI (FCP) across the FC-AL interface.

All enclosure services are performed by the processor on the SOC+ chip on the appropriate IB. If only one IB is installed and operational, that IB performs the enclosure services. If two IBs are installed and operational, the enclosure services are performed cooperatively by the IBs.

Enclosure services provide and/or accept configuration and maintenance information through the FPM display and the host software. An IB unit may override instructions from the host or from the FPM operator if the instructions conflict with the requirement for maintaining proper and safe operating conditions in the enclosure.

The following units generate or receive enclosure status or control information:
- Power supplies
- Fan trays
- Interface boards (IBs)
- GBICs
- Disk drives
- DD backplanes

System Architecture

Front Panel Module (FPM)

The A5000 disk enclosure has a Front Panel Module (FPM) which accepts touch switch inputs and provides graphic and alphanumeric information on an electro-luminescent (EL) display screen. In addition, it has three LED indicators that provide summary status information. The FPM has three main functions:

• Displays enclosure, drive, and loop status, and highlights errors

• Displays vital enclosure data—WWN, box name, box ID, and so on

• Configures the enclosure—box name, loop configuration

The FPM supplements the enclosure services provided through the SCSI-3 Environmental Services command set. The FPM provides access to the same enclosure services and to some additional services even if the FC-AL is not connected or if the host processor's monitor and keyboard are distant from the array enclosure.

Touch Screen

The touch screen has a 3 x 6 array of touch areas which are under-labeled by images from the graphic display indicating when they are active and what action will be performed by each. The touch screen provides numeric inputs to the enclosure and provides buttons for stepping through the diagnostic and display menus.

Touch Screen Main Features

• Bright, clear display

• 18-button touch screen for configuration and status

• Three-level menu system:
  – Level 1—Menu and system view
  – Level 2—FRU groups and setup
  – Level 3—Individual FRU information and control

• Three system status summary LEDs

Figure 2. Touch screens.

Fiber Cable

The supported fibre cable is 50/125 multi-mode, duplexed, UL910- and UL1651-approved with OFNP marking. The connector is an SC connector with UL94V-2 rating (minimum). If the connectors do not have an overall jacket that keeps them together, it is advisable to color-code the connectors. Color-coding is particularly important in long cables (where the host and array are in locations remote from each other).

RAID Support

Sun™ Enterprise Volume Manager™ supports RAID technology to optimize performance, availability, and user cost. This technology improves performance, reduces recovery time in the event of file system errors, and increases data availability even in the event of a disk failure. Sun Enterprise Volume Manager supports four RAID levels that provide varying degrees of availability with corresponding trade-offs in performance and cost:

- RAID 0 (striping and concatenation) enables data to span more than a single disk. While performance is improved, the lack of redundancy in this level leaves data unprotected.

- RAID 1 (mirroring) enables users to keep multiple copies of their data. In the event of a disk failure, data can be obtained from the remaining good copy, increasing data availability.

- RAID 0+1 (striping plus mirroring) provides the data protection of RAID 1 with the performance benefit of RAID 0.

- RAID 5 (striping with distributed parity) offers the ability to reconstruct data in the event of a single disk failure. Significantly less expensive than mirroring, RAID 5 is a common choice when low-cost availability is desired.

Dynamic Multi-Pathing

Multi-pathing has traditionally meant that there are two hosts connected to a dual-ported drive set, each host with only one data path to the drives, with one host on each port. In order to take advantage of multiple access and failover capabilities, additional software is required to manage the two paths. This single data path has been a traditional operating system restriction. The traditional OS has only one physical path for each device, and if that path fails, data access for that host is lost.

The dual IBs in the A5000, along with dual-ported disk drives, allow a configuration to have four possible data paths to a single enclosure. The drives, being dual-ported, also allow for a dual data path within the enclosure. This adds greatly to the overall reliability of the data path.

Now with Solaris™ 2.6 (or 2.5.1 SHWP 8/97), multiple paths per host to the same drives are recognized by the operation system. Host connections can now be redundant to dual ported drives. With the addition of Sun Enterprise Volume Manager Release 2.5 with Dynamic Multi-Pathing, these multiple pathways provide for better performance and automatic failover should a data path problem occur.

Hot Relocation

Data availability is needed even when a disk fails. Sun Enterprise Volume Manager permits users to specify disks as spares—disks that can be used for data reconstruction in the event of a disk failure. Data is automatically reconstructed and generated on the spare device, enabling the entire data set to maintain its availability.

RAID Support *(cont.)*

Disk Groups

In the event of a system failure, users need assurance that access to their data can be obtained quickly. Sun Enterprise Volume Manager enables users to group disks and the volumes and file system that reside on them into disk groups. A disk group can be exported from a failed system and imported onto another system, providing users with access to the data.

On-line Resizing

File systems, and consequently the volumes on which they reside, change and grow over time. In the past, as file systems became full, administrators were required to take the file system off-line, back up the data, create a larger file system and restore the data. With Sun Enterprise Volume Manager, volumes and their UNIX® file systems (UFS) can grow on-line, without disruption of user access. This capability increases data availability and eases administration.

On-line Backups

Backups are an essential part of any data management strategy yet pose problems in enterprises that run 24 hours a day, seven days a week, for 365 days a year. The traditional technique of performing backups during scheduled downtimes may be unacceptable for many organizations and application environments.

Sun Enterprise Volume Manager supports on-line backups through the use of *snapshots*, read-only copies of the volume and/or file system. When a snapshot is created, write operations continue to modify the active volume or file system, enabling application access to continue without interruption.

Performance Analysis Tools

Sun Enterprise Volume Manager includes performance analysis tools. The system can monitor the I/O load and obtain statistics on reads and writes at the disk and volume level. With this capability, users can monitor I/O performance and isolate bottlenecks. Once identified, bottlenecks can be removed by moving or reorganizing data, resulting in improved performance.

System Architecture

Performance

Performance Summary

- The Sun Enterprise Network Array's highest bandwidth is 190 MB/sec., dual-loop, in 1-MB sequential reads.

- The Sun Enterprise Network Array's highest I/O per second is 14,000, dual-loop, in 1-KB random reads.

RAID Benchmark Configuration

- Ultra™ Enterprise™ 4000 with one GB memory and four 167-MHz UltraSPARC™ processors running Solaris 2.6.

- Random I/O size is 2 KB; sequential I/O size varies to support optimum configuration.

- Benchmark tool is `vxbench`; no logging is utilized.
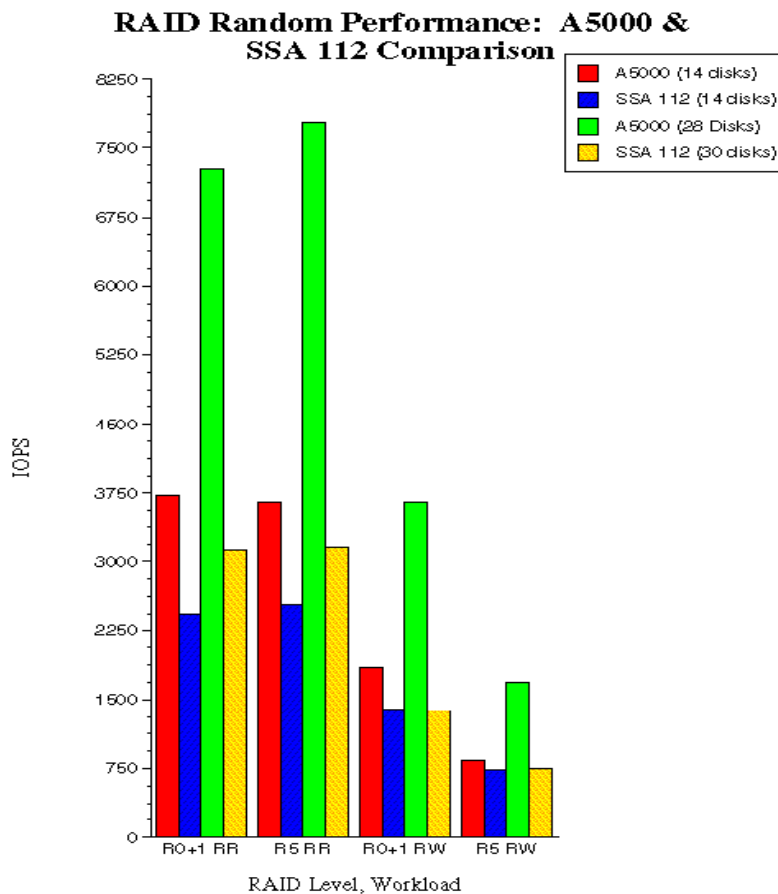
Figure 3. RAID random performance: A5000 & SPARCstorage Array 112 comparison.

In random performance testing, in both RAID 0+1 and RAID 5 configurations, the A5000 outperforms the SPARCstorage Array using a relatively equivalent numbers of drives. Comparing enclosure to enclosure (in which case the A5000 uses fewer drives than the SPARCstorage Array), the A5000 still outperforms the SPARCstorage Array.

Performance Summary *(cont.)*
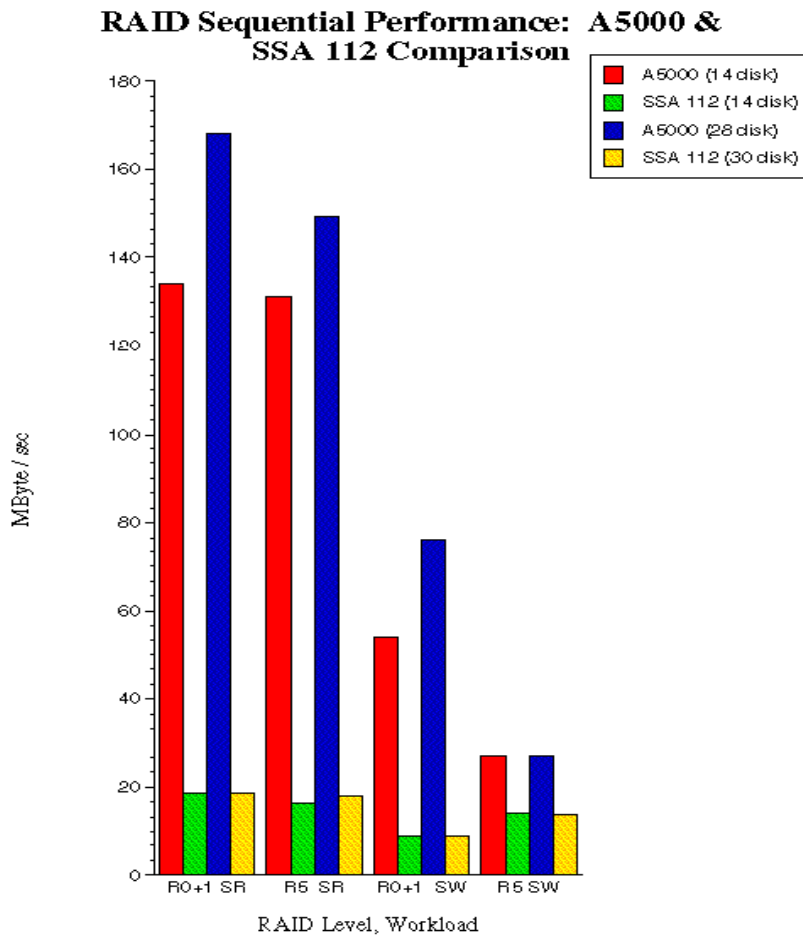
Figure 4. RAID sequential performance: A5000 and SPARCstorage Array 112 comparison.

In sequential testing, the A5000 is significantly faster in read performance than the SPARCstorage Array. In sequential writes, the A5000 is faster than the SPARCstorage Array in RAID 5 and much faster than the SPARCstorage Array in RAID 0.

System Architecture

Performance Summary *(cont.)*

Test Results

Test Parameter	RAID 0+1				RAID 5			
	Sun Enterprise Network Array		SPARCstorage Array Model 112		Sun Enterprise Network Array		SPARCstorage Array Model 112	
Configuration	14x9.1-GB drives		14x2.1-GB drives		14x9.1-GB drives		14x2.1-GB drives	
Workload	IOPS	MB/sec.	IOPS	MB/sec.	IOPS	MB/sec.	IOPS	MB/sec.
Random read	3,728		2,442		3,657		2,538	
Random write	1,850		1,392		844		739	
Sequential read		134		19		131		16
Sequential write [a]		54 *		9		27 *		14
Configuration	28x9.1-GB drives		30x2.1-GB drives		28x9.1-GB drives		30x2.1-GB drives	
Workload	IOPS	MB/sec.	IOPS	MB/sec.	IOPS	MB/sec.	IOPS	MB/sec.
Random read	7,270		3,131		7,787		3,152	
Random write	3,648		1,385		1,683		752	
Sequential read		168		19		149		18
Sequential write *		76 *		9		27 *		14

a. All performance testing is preliminary; performance is expected to improve.

Raw Benchmark Configuration

- Ultra Enterprise 4000, 3 GB memory, eight 250-MHz UltraSPARC processors running Solaris 2.6.
- Load is generated by using one or more I/O requests per drive utilizing `vxbench`.
- "Departmental" indicates one tabletop array (14 x 9.1-GB, 7200-rpm Seagate FC-AL drives).
- "Datacenter" indicates four rackmounted arrays (14 x 9.1-GB, 7200-rpm Seagate FC-AL drives).

	A5000 Departmental	A5000 Datacenter	SPARCstorage Array
Maximum IOPS	3,782 IOPS	14,115 IOPS	3,340 IOPS
Maximum throughput	147 MB/sec.	184 MB/sec.	19 MB/sec.

System Architecture

Requirements and Configuration

System Requirements

The Sun Enterprise Network Array disk array is a mass storage subsystem using network technology and gigabit FC-AL to create high-performance, high-availability storage networks. The enclosure is designed to be mounted in a standard Sun expansion cabinet or stand alone on a tabletop.

System Configuration

The configuration choices for the Sun Enterprise Network Array should be application-driven. Balance availability, performance and price in determining the configuration:

- When configuring for availability, data and hardware redundancy are key. The choice of RAID method determines the level of data redundancy.
  - Mirroring (RAID 1) is best for availability in mission-critical applications and the only certain solution for disaster tolerance.
  - Parity (RAID 5) also offers good availability.
- When configuring for performance, the best benchmark is the application. Striping (RAID 0) is the largest performance booster.
- When price is the priority, minimum hardware and RAID 0 might be the best choice.

Front components
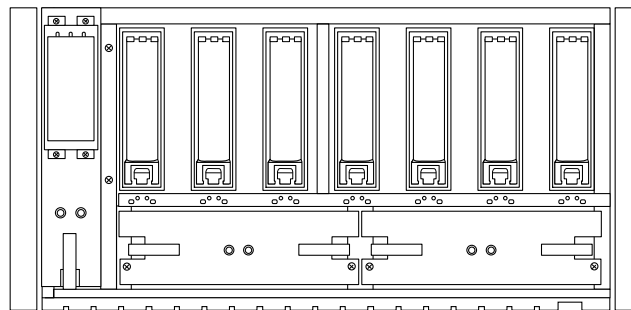
Figure 5. Front components.

The Sun Enterprise Network Array enclosure is accessible from both the front and the rear. At the front of the array is the first row of seven FC-AL hot-plug disk drives. Also accessed from the front of the system are two hot-plug power supplies and the first of two hot-plug fan trays. The front panel module is the electro-luminescent display which provides information on local test and status.

System Architecture
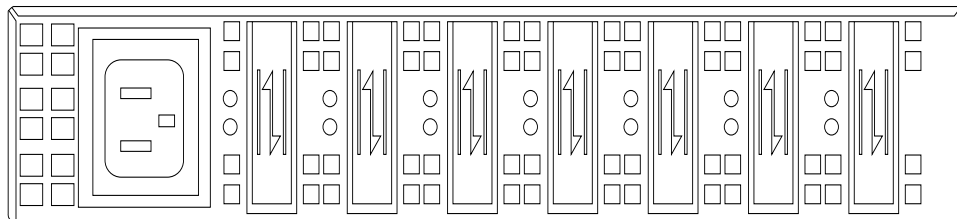
System Configuration *(cont.)*

Rear components
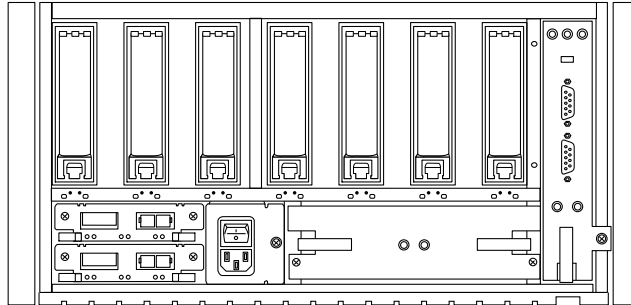
Figure 6. Rear components.

At the rear of the Sun Enterprise Network Array is the second row of FC-AL disk drives. Also, the third power supply and the other fan tray are accessed from this side, as well as two interface boards, each of which holds one GBIC module.
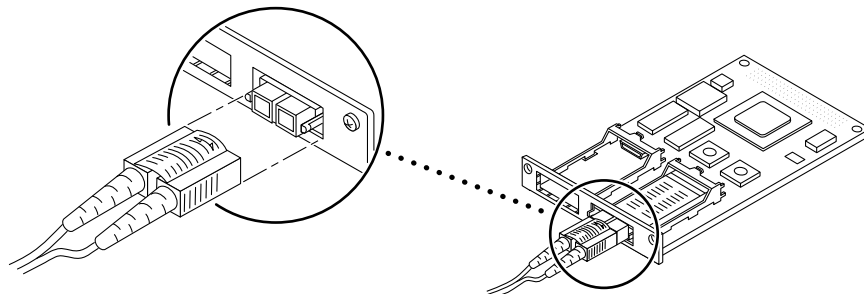
FC-AL seven-port hub

Figure 7. FC-AL seven-port hub.

The FC-AL hub supplied as an option is a seven-port device which simplifies the cabling of arrays. Each slot can hold one GBIC optical module, up to a total of seven. Two hubs can be mounted at the top of an Enterprise Expansion cabinet.

System Architecture
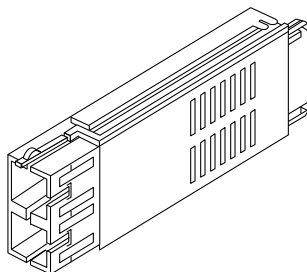
System Configuration *(cont.)*

FC-AL SBus host adapter

Figure 8. FC-AL SBus host adapter

The FC-AL host adapter for the Sun Enterprise Network Array is a dual-channel, 100-MB/sec. SBus card, which includes one GBIC optical module and support for one additional module. Up to four arrays of 56 drives or 509 GB in a single cabinet can be connected to a single host adapter.
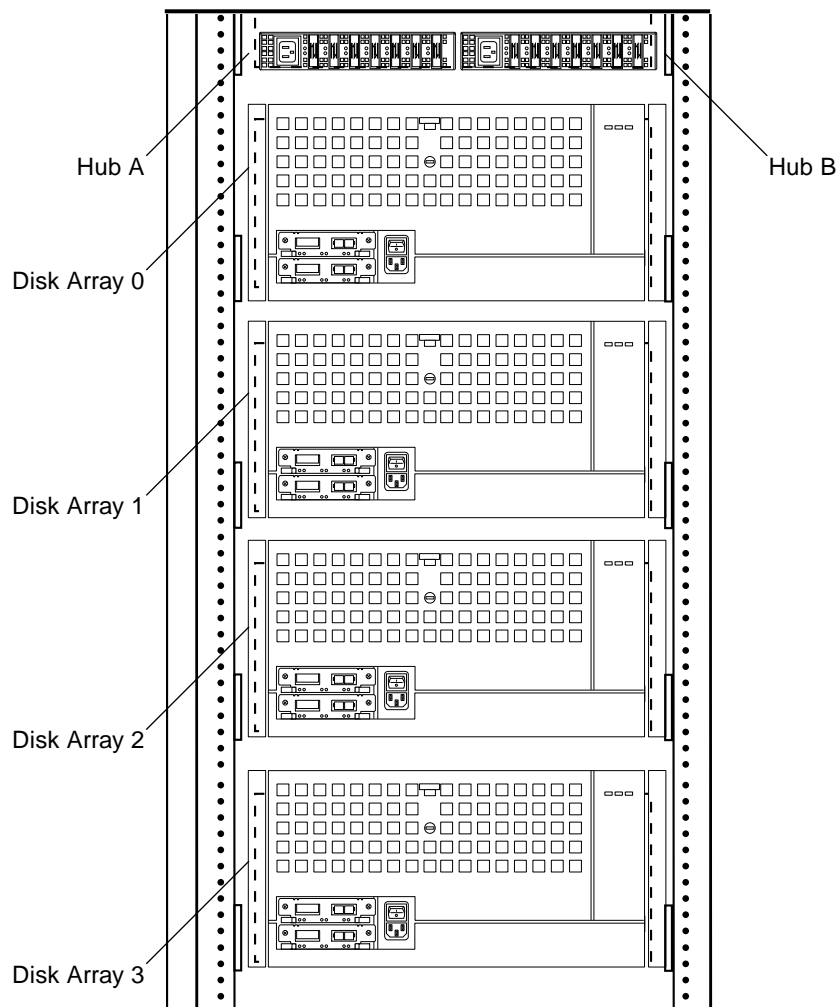
GBIC

Figure 9. Gigabit Interface Converter (GBIC).

The Gigabit Interface Converter for the Sun Enterprise Network Array converts FC-AL electrical signals to optical signals for connecting fiber optic cables. It is a hot-plug device supported on the array interface boards, host adapter and hub.

System Architecture

System Configuration *(cont.)*

Rack-mounting the Sun Enterprise Network Array

Hub A

Hub B

Disk Array 0

Disk Array 1

Disk Array 2

Disk Array 3

Figure 10. Rack-mounting the Sun Enterprise Network Array.

Up to four Sun Enterprise Network Array systems can be mounted in a Sun™ Enterprise Expansion Cabinet. Each array is cabled into two FC-AL hubs at the top of the system. In this configuration it is possible to store up to 510 GB in one cabinet. Pre-configured rack-mount assemblies are offered, or the array may be rackmounted in the field with optional hardware.

System Architecture
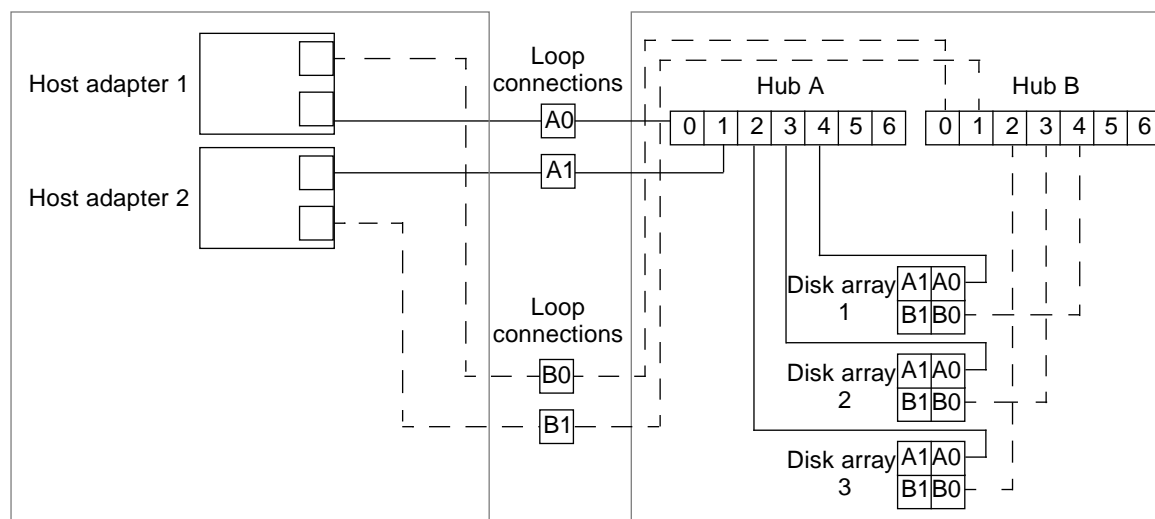
Interconnect

Figure 11. Interconnect.

The Sun Enterprise Network Array uses 50-micrometer fibre optic cables to connect arrays, hubs and host adapters. Fiber optic cables are keyed and connect to the GBICs on each end. Each interface board and host adapter is supplied with one GBIC, standard. Each interface board is capable of supporting two GBICs each. Additional GBICs can be added to increase connectivity as illustrated above. In addition, FC-AL hubs increase availability and simplify cabling of multiple arrays. The dual-loop, dual-hub configuration outlined above is an example of the redundant channels possible with two hubs and two host adapters.

System Architecture

System Management

System Administration

All active FRUs can be installed or replaced without powering down the subsystem. Disk drives can be exchanged by simply opening either the front or back door of the enclosure and then making the exchange.

For all other components it is necessary to first remove the door and then remove the trim panel/hinge that supports the door and covers the other components. The hot-pluggable FRUs are:

- 3.5-inch disk drives (must match backplane type—seven 1.6-inch drives per side)
- Power supplies (at least two should remain installed to maintain power)
- Fan trays (must be exchanged promptly as overheating will shut down enclosure)
- Front panel module (removal does not affect unit operations)
- Interface boards (at least one must remain installed or unit powers down)
- Gigabit interface converters (one per loop maintains continuity)

Software

Sun™ Enterprise Volume Manager™ 2.5 provides customers with the following benefits:

- **Features**
  - RAID levels 0, 1, 0+1, 5
  - Dynamic multipathing
  - Hot relocation
  - Disk groups
  - Volume resizing
  - File system expansion
  - On-line snapshots
  - Graphical user interface
  - Performance analysis tool

- **Benefits**
  - Improves performance and data availability
  - Balances performance and adds reliability
  - Increases data availability
  - Facilitates movement of data between hosts
  - Enables volumes to change as needs dictate
  - Enables file systems to grow dynamically
  - Facilitates on-line backups
  - Eases administration
  - Enables problem (bottleneck) isolation and tuning

Operating System

Solaris™ 2.5.1 (8/97) or Solaris 2.6 must be used to support the Sun™ Enterprise Network Array™.

Ordering Information

Sun™ Enterprise Network Array™ Systems

Order Number	Title and Description

Order Number   **Title and Description**

SG-XARY010A-45G   45.5-GB Sun™ Enterprise Network Array™

– System includes five 9.1-GB, 7200-rpm FC-AL drives, two power supplies, one interface board and a two-meter fibre optic cable.

SG-XARY010A-127G   127.4-GB Sun Enterprise Network Array

– System includes fourteen 9.1-GB, 7200-rpm FC-AL drives, three power supplies, two interface boards and a two-meter fibre optic cable.

SG-XARY011A-127G   127.4-GB Sun Enterprise Network Array

– Rack-mount system includes fourteen 9.1-GB, 7200-rpm FC-AL drives, three power supplies, two interface boards and a two-meter fibre optic cable.

SG-XARY012A-254G   254.8-GB Sun Enterprise Network Array

– System includes two arrays with fourteen 9.1-GB, 7200-rpm FC-AL drives each and two seven-port FC-AL hubs mounted in an Enterprise expansion cabinet.

SG-XARY012A-509G   509.6-GB Sun Enterprise Network Array

– System includes four arrays with fourteen 9.1-GB, 7200-rpm FC-AL drives each and two seven-port FC-AL hubs mounted in an Enterprise expansion cabinet.
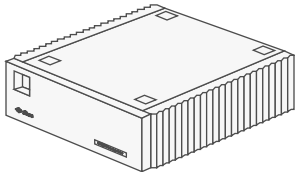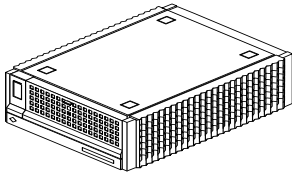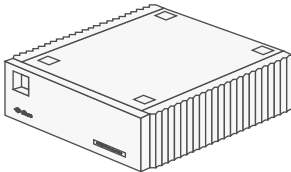
Sun Enterprise Network Array Options

Order number	Option Description	Maximum number supported	Comments
X6730A	100-MB/sec. FC-AL SBus dual-channel host adapter, including one GBIC module		2 GBICs maximum
X6732A	100-MB/sec. FC-AL seven-port hub, no GBICs included		7 GBICs maximum
X6731A	100-MB/sec. FC-AL GBIC for host adapter or hub		
X6708A	9.1-GB, 7200-rpm FC-AL disk drive		
X6734A	Interface board with one GBIC	2 per array	2 GBICs maximum
X9687A	Power supply	3 per array	
X9650A	Array rack mounting kit	1 array	
X6735A	Hub rack mounting kit	2 hubs	
X973A	Two-meter fiber optic cable		included with array
X978A	15-meter fiber optic cable		included with array

Upgrade Paths

Protect your investment in SPARCstorage™ Arrays by upgrading to the Sun™ Enterprise Network Array™ A5000. Sun-to-Sun and Competitive Upgrades to the A5000 provide excellent trade-in values for older SPARCstorage Array systems, making it more cost-effective to migrate to the latest technology. See the ordering information below for available upgrade configurations.

From	Receive	Return
SPARCstorage Array	Sun Enterprise Network Array	SPARCstorage Array

SPARCstorage™ Array Upgrade Ordering

Order Number   **Title and Description**

UG-A5000-45GB   SPARCstorage Array 10X or 11X Upgrade to 45-GB Sun A5000 Array

– Customer returns a minimum of one 20-GB model 10X /11X SPARCstorage Array.

UG-A5000-127GB   SPARCstorage Array 11X or 21X Upgrade to 127-GB Sun A5000 Array

– Customer returns a minimum of one 37-GB model 11X or 21X Arrays.

UG-A5000-9GB-DISK   Upgrade to 9-GB Sun Enterprise Network Array disk drive

UG-A5000-254GB   SPARCstorage Array 11X or 21X Upgrade to 254-GB Sun A5000 Array

– Customer returns a minimum of two 40-GB model 11X or 21X Arrays.

Competitive Upgrade Ordering

Order Number   **Title and Description**

CU-A5000-45GB   Competitive Upgrade to 45-GB Sun Enterprise Network Array

– Customer returns a minimum of one 20-GB competitive array.

CU-A5000-127GB   Competitive Upgrade to 127-GB Sun Enterprise Network Array

– Customer returns a minimum of one 37-GB competitive array.

CU-A5000-254GB   Competitive Upgrade to 254-GB Sun Enterprise Network Array

– Customer returns a minimum of two 40-GB competitive arrays or one EMC 3000 series storage system with 80 GB of disk storage.

Upgrade

Service and Support

SunSpectrum[SM] is an innovative and flexible service offering that allows customers to choose the level of service best suited to their needs — ranging from mission-critical support for maximum solution availability to backup assistance for self-support customers. SunSpectrum provides a simple pricing structure in which a single fee covers support for an entire system, including related hardware and peripherals, the Solaris[TM] operating system software, and telephone support for Sun[TM] software packages. The majority of Sun's customers today take advantage of the SunSpectrum program, underscoring the value it represents. Customers should check with their local SunService[SM] representative for program/feature variance and availability in their area.

FEATURE	SUNSPECTRUM[SM] PLATINUM[SM] Mission-Critical Support	SUNSPECTRUM[SM] GOLD[SM] Business-Critical Support	SUNSPECTRUM[SM] SILVER[SM] Systems Support	SUNSPECTRUM[SM] BRONZE[SM] Self Support
Systems Features				
Systems approach coverage	Yes	Yes	Yes	Yes
System availability guarantee	Customized	No	No	No
Account Support Features				
Service account management team	Yes	No	No	No
Personal technical account support	Yes	Yes	No	No
Account support plan	Yes	Yes	No	No
Software release planning	Yes	No	No	No
Onsite account reviews	Monthly	Semi-annual	No	No
Site activity log	Yes	Yes	No	No
Coverage / Response Time				
Standard telephone coverage hours	7 day/24 hour	7 day/24 hour	8 a.m.–8 p.m., Monday–Friday	8 a.m.–5 p.m., Monday–Friday
Standard onsite coverage hours	7 day/24 hour	8 a.m.–8 p.m., Monday–Friday	8 a.m.–5 p.m., Monday–Friday	N/A
7 day/24 hour telephone coverage	Yes	Yes	Option	No
7 day/24 hour onsite coverage	Yes	Option	Option	N/A
Customer-defined priority setting	Yes	Yes	Yes	No
– Urgent (phone/onsite)	Live transfer/ 2 hour	Live transfer/ 4 hour	Live transfer/ 4 hour	4 hour / N/A
– Serious (phone/onsite)	Live transfer/ 4 hour	2 hour/next day	2 hour/next day	4 hour / N/A
– Not critical (phone/onsite)	Live transfer/ customer convenience	4 hour/ customer convenience	4 hour/ customer convenience	4 hour / N/A
Additional contacts	Option	Option	Option	Option

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FEATURE	SUNSPECTRUM PLATINUM Mission-Critical Support	SUNSPECTRUM GOLD Business-Critical Support	SUNSPECTRUM SILVER Systems Support	SUNSPECTRUM BRONZE Self Support
Enhanced Support Features				
Mission-critical support team	Yes	Yes	No	No
Sun Vendor Integration Program (SunVIP™)	Yes	Yes	No	No
Software patch management assistance	Yes	No	No	No
Field change order (FCO) management assistance	Yes	No	No	No
Remote Systems Diagnostics				
Remote dial-in analysis	Yes	Yes	Yes	Yes
Remote systems monitoring	Yes	Yes	No	No
Remote predictive failure reporting	Yes	Yes	No	No
Software Enhancements and Maintenance Releases				
Solaris enhancement releases	Yes	Yes	Yes	Yes
Patches and maintenance releases	Yes	Yes	Yes	Yes
Sun unbundled software enhancements	Option	Option	Option	Option
Internet and CD-ROM Support Tools				
SunSolve™ license	Yes	Yes	Yes	Yes
SunSolve EarlyNotifier℠ service	Yes	Yes	Yes	Yes

Service and Support

Warranty

The warranty on the array hardware is one year. All FC-AL disk drives carry a five-year warranty. Software is warrantied for 90 days.

Education

- Support Readiness Training
- IQ Kit Sales Guide
- IQ Kit Tech Guide
- SunU

Professional Services

SPARCstorage™ ArrayStart™

SPARCstorage™ ArrayStart™ provides an installation and custom-configuration service that quickly gets mission-critical data-center applications up and running. For one fixed fee, this service includes consultation for determining the configuration that best meets the customer's needs, installation of the hardware and RAID management software, and configuration to the appropriate RAID profile determined during the consultation.

SDS to Volume Manager

Data Migration

A Sun Professional Service consultant will deliver four days of onsite consulting services to assist customers who wish to migrate their mission-critical data from existing storage system to a new array. This service will help customers complete the transition with minimal downtime and without risking loss of their valuable data. Specially trained Sun™ consultants will use their extensive data-migration expertise to complete the service in the most cost- and time-effective manner available. Sun consultants will also fully integrate and optimize the Sun™ Enterprise Network Array™ into the customer's computing environment.

If desired, customers can choose tasks from the following list to customize the service to meet their specific business needs:

- Design and configuration planning
- Capacity planning
- Performance tuning and optimization

Travel and expenses incur an additional charge for delivery requiring more than 50 miles of travel. When this service is desired by the customer, the account manager will contact the SunPS℠ Data and Storage Management Competency Practice to schedule delivery of the service.

Glossary

Arbitrated loop	A loop topology where two or more ports can be interconnected, but only two ports at a time may communicate.
Channel	An interface directed toward high-speed transfer of large amounts of information.
Fabric	A group of interconnections between ports that includes a fabric element.
Fiber	A wire or optical strand. Spelled "fibre" in the Fibre Channel name.
Fiber-optic cable	Jacketed cable made from thin strands of glass through which pulses of light transmit data. Used for high-speed transmission over medium to long distances.
Frame	An indivisible unit for transfer of information in Fibre Channel.
Full duplex	A communications protocol that permits simultaneous transmission in both directions, usually with flow control.
GBIC	Gigabit Interface Converter.
Hub	A device for connecting fiber cables.
IP	Internet Protocol. A set of protocols developed by the United States Department of Defense to communicate between dissimilar computers across networks.
Laser	Light Amplification by Stimulated Emission of Radiation. A device for generating coherent radiation in the visible, ultraviolet, and infrared portions of the electromagnetic spectrum.
LED	Light Emitting Diode.
Link	One inbound fiber and one outbound fiber connected to a port.
Micron	One millionth of a meter. Also called "micrometer."
Multi-mode fiber	An optical waveguide which allows more than one mode (rays of light) to be guided.
Network	An arrangement of nodes and connecting branches, or a configuration of data processing devices and software connected for information exchange.
N_Port	A port attached to a node for use with point-to-point or fabric topology.
NL_Port	A port attached to a node for use in all three topologies (point-to-point, arbitrated loop or fabric).
Node	A device that has at least one N_Port or NL_Port.

Optical fiber	Any filament of fiber, made of dielectric material, that guides light.
Point-to-point	A topology where exactly two ports communicate.
Port	An access point in a device where a link attaches.
Protocol	A convention for data transmission that defines timing, control, format and data representation.
Receiver	The circuitry that receives signals on a fiber, and the ultimate destination of data transmission.
Responder	The logical function in an N_Port responsible for supporting the exchange initiated by the originator in another N_Port.
SCSI	Small Computer Systems Interface. An ANSI standard for controlling peripheral devices by one or more host computers.
Serial transmission	Data communication mode where bits are sent in sequence in a single fiber.
Single-mode fiber	A step index fiber waveguide in which only one mode (ray of light) will propagate above the cutoff wavelength.
Switch	The name of an implementation of the fabric topology.
Topology	The components used to connect two or more ports together. Also, a specific way of connecting those components, as in point-to-point, fabric, or arbitrated loop.
Transceiver	A transmitter/receiver module.
Transfer rate	The rate at which bytes or bits are transferred, usually measured in MB/sec.

Glossary

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